Campus Guidance System for International Conferences Based on OpenStreetMap

Ricky Jacob[1], Jianghua Zheng[1], Błażej Ciepłuch[1], Peter Mooney[2], and Adam C. Winstanley[1]

[1] Geotechnology Group, Department of Computer Science, National University of Ireland Maynooth, Co. Kildare, Ireland
[2] Environmental Research Centre, Environmental Protection Agency, Richview, Clonskeagh, Dublin 14, Ireland
rjacob@cs.nuim.ie, jianghua.zheng@nuim.ie, bciepluch@cs.nuim.ie, peter.mooney@nuim.ie, adam.winstanley@nuim.ie

Abstract. We present a web-based, multi-lingual, campus guidance system with emphasis on pedestrian navigation aimed at providing support for delegates attending International Conferences at the National University of Ireland Maynooth (NUIM) campus. A special campus guidance system could improve the logistics of the conference and potentially attract more delegates to the conference. The Cloudmade Web Map Lite API which uses OpenStreetMap has been used for creating this interface. The system generates shortest pedestrian paths using both outdoor pavements and indoor corridors between various buildings and points of interests (POI). For visual assistance in pedestrian navigation geotagged images are used along the path at certain points in the route, such as road intersections, when the user needs to get their orientation correct. The interface is currently available in both English and Chinese language.

Keywords: Campus guidance system, Pedestrian navigation, Cloudmade, Maps API, OpenStreetMap, International conference, WebGIS, LBS.

1 Introduction

Where is the conference dinner? Where are the conference sessions on? What is the best pub in town? These are all common questions asked by delegates when they are attending a conference. These type of queries are among a set of challenging navigation tasks for delegates attending conferences and meetings. So the main motivation for this research was to see how feasible it is to build a pedestrian navigation system built completely on open technologies and freely avaialable data and also to maximise re-use potential for other events in the campus. Delegates often arrive to the location of a conference with only a short time to familiarise themselves with the campus, the local transportation system, and to find what the best features in the near by locations are. This paper describes the development of a campus navigation system to assist delegates

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attending conferences at the NUIM campus. While the system has been initially developed for the NUIM campus and a specific conference it has been designed to extend to other conferences within NUIM and beyond.

1.1 Existing Campus Guidance and Navigation Systems

Many visitors and new students come to the university campus at NUIM every year. A campus guidance system is always a helpful tool for those unfamiliar with the campus to orientate themselves and guide them around the campus. There are some information systems that have already been developed for this purpose. Most of these applications use commercial GIS components based on Component Object Model (COM/COM+) technology. Changbin et al[1] used MapX to provide a campus navigation service of Wuhan University in China. Baaser et al[2] and Guangchen[3] utilize ArcIMS (ESRI Map Server) to develop a campus navigation prototype. [4] used SuperMap Objects to build a campus navigation system for Henan Polytechnic University in China. GIS components of the systems are commercial and their data is generally privately owned and without regular update. With the widespread use of Google Maps and Virtual Earth mapping it is now easy to obtain free mapping data. This has allowed developers to build Location Based Services (LBS) for environments such as university campuses. [5] was one the earliest groups that focused on campus navigation and guidance system using Google Maps and since this many such applications become available. [6] developed a campus information system based on Google Maps for Xinjiang University in China. The University College London [7] has created a campus navigation system built using Google maps API. Using Google Maps or Virtual Earth Map APIs some campus information applications can provide 3D services. [8] utilize VRML (Virtual Reality Modeling Language) to build campus navigation system in 3D environment. Tsinghua University, Industrial and Commercial University of Chongqing, Nantong University have all established "virtual campuses" for visitor guidance [9]. There are also some other campus navigation systems with special functions or demonstrating specific technologies. Takraouri et al[10] discussed ubiquitous computing architecture of the eyeJOT, a new context-aware smart campus information system combining ambient wall-sized displays with location-aware, context-sensitive information sharing on mobile devices. Fengyuan et al[11] discussed Gippy, which is a campus GIS information system supported by P2P technology. Jia et al[12] show their research on a Service Orientated Architecture for campus information modelling. Applications like these could very well be used for delegates attending the international conferences held on a university campus. However participants usually have different goals from other visitors and new students on campus. Participants require more specific information from a campus guidance system. Compared to general campus navigation or information systems these type of applications are relatively‘ few. One such example is [13] who discussed a simple prototype of such an application based on MapXtreme.

The last few years have seen an increased interest in the design of pedestrian navigation systems for mobile phones. Some Nokia phones now ship with Nokia

Maps 2.0 which enhances pedestrian navigation and also provides city guides in a new improved interface. There has been considerable research carried out which evaluates various modes of pedestrian navigation feedback. The various modes used for input or output are audio or voice feedback [14], textual turn by turn instructions, graphical map interface [15][16], image based navigation [17], and haptic feedback [18]. Multi-modal techniques [19] are used when more than one mode is used for providing navigational cues. In this paper we describe how we can use freely available light weight mapping API to create a pedestrian navigation module within a campus guidance system.

1.2 Using Web-Based Maps API

Integrated web applications or *mashups* are increasingly being used. Mashups bring together utilities of two or more applications into one common interface. Research shows that mapping mashups are the most popular among all the mashups deployed. Various sites list and review these mashups. One such site is Programmableweb.com[20]. In the recent years there has been an increase in the use of free Maps API provided by various web map services [21] [22] [23] [24] to create ones own map based web service using their interface and data along with some of the users own data. Some of the hugely popular and successful mashups like *Kayak* for hotels listing in US, and *Trulia* for real estate listing have shown how with proper design and planning one can generate revenue using such freely available map APIs. When building such applications the availability of complete digital map data for the area of interest is an issue particularly if the extent of the area is not within the limits of a major city. But when this is extended to smaller towns and cities the availability of reasonably good digital web-based maps is poor. In this paper we look at maps of the NUIM area across various web based map service providers like Microsoft's Bing Maps, Google Maps, Yahoo Maps and OpenStreetMap and we find for most map providers that there is a lack of high quality spatial data for our area of interest.

Open Street Map(OSM)[23] is a free map of the entire world. OSM is a knowledge crowdsourcing model that provides user-generated street maps. There has been various geo-wiki applications [25][26] that utilises user-generated content for its maps. However OSM is probably the most extensive and effective project currently under development [27]. Some recent applications have even developed 3D routing functionality based on OpenStreetMap, geovis of `OSM-3D.org` is an recent example. Since OpenStreetMap is has a free creative commons open source license model it allows a very flexibile model of access to the underlying spatial data for developers and the ability to use the various APIs. The most important is it provides good quality user-generated street maps efficiently. OSM has a map editor that enables input of user generated content. It also provides basic GIS functions, such as zoom in/out, pan and feature information tools. CloudaMade has provided a lightweight maps API using which we can build our own custom applications. It also provides an API offering higher level GIS functions such as a routing API and browser API for mobile phones to view OSM. In our work, the

OpenStreetMap for Maynooth is a rich spatial model with many point, line and polygon features. The NUIM campus has been mapped extensively to almost its entirety and thus used as the test bed for creating this prototype to demonstrate how we can bring together the capabilities of a personalized Pedestrian Navigation System using a Maps API with the OSM providing the mapping to create a campus guidance system.

In developing a system such as this there is an emphasis on creating an system which can be reused and not limited to a one time use [28]. The objective of the present work is to provide a campus guidance system for the delegates attending the China-Ireland Conference on Informations and Communication Technologies 2009 [29]. However, it should be easily extendible to other conferences in NUIM and possibly in other university locations in Ireland. The CloudMade Web Maps Lite API [30] for routing has been used in this work as it is built on the OpenStreetMap database. The remainder of this paper is organised as follows. In the next section we discuss the creation of the OSM map the NUIM Campus and Maynooth Town. Then the need for a campus guidance system is discussed and followed by our proposed system. Some lessons learnt during this work are also discussed and the scope for future work is discussed at the end of the paper.

2 Creation of Map Data

OSM data collection for areas in and around Maynooth started in December 2008. A GPS device manufactured by Globalsat(Model: DG-100) was used for this propose. This device has gained popularity with the OSM community and the drivers for the Linux OS are available. For reading stored GPS tracks and saving them on the computer the application called GPS Babel [31] was used. The first stage of data collection and mapping involved preparing the line features for roads and footpaths within the NUIM Campus. The more detailed NUIM Campus containing all the buildings and other points of interest(POI) was done using an aerial photograph of the campus. Using the GPS device the road network for the entire town of Maynooth and some of the surrounding hinterlands were mapped. A bicycle mounted with the GPS device in the front was used to travel across the small streets in and around the town of Maynooth. Travel by bicycle instead of by foot saved much time. While capturing the positions of POIs and other features of interest the attribute data for the same were also collected. For example the names of streets (both in English and Irish), the names of restaurants, shops, and also the house numbers in various localities. Various OSM users across Ireland are updating the OSM database and as of July 2009 the entire network of major roads and highways across Ireland has been mapped. It is noticeably that most of the cities in Ireland are mapped extensively in OSM. Some of the smaller towns are poorly represented with OSM at present. Figure 1 shows a large residential area in Maynooth where details like street names and house numbers were captured.

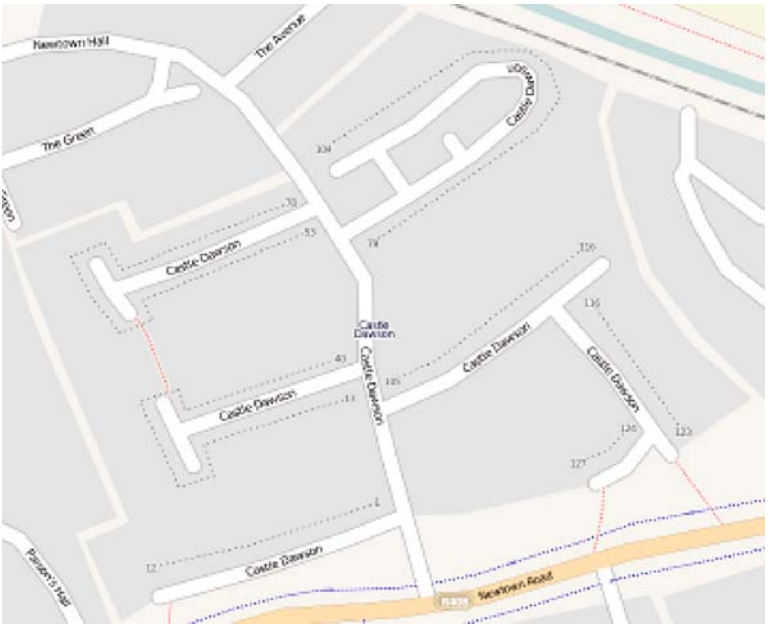

Fig. 1. An example of high resolution mapping in OSM. This is the Castle Dawson estate in Maynooth.

3 Campus Navigation System

There are a number of requirements of a campus navigation system. These requirements are from the two sides of a conference: participants of conferences held on campus and the conference organisers themselves. From the organisers point of view there is the requirement that the campus navigation system for the conference can provide all the relevant information to the delegates in a simple easy to use interface. Many conferences are held in NUIM each year so the availability of a campus navigation system will be always useful. Rather than creating separate systems for each conference the ultimate goal is to have a standard campus navigation tool which can reused and be easily customised by the conference organisers to satisfy their own specific requirements. After a brief survey of the academic and research staff in the Department of Computer Science at NUIM the most frequently asked questions of delegates of a conference are as follows:

- Where are the venues where the conference sessions will be held?
- How does one get to the conference venue?
- What are the various modes of transport available?
- What is the optimal route to get to from one location to another or from one POI to another POI?
- Where are the accommodation services?

- Where are the nearest restaurants that serves the food 'I' like?
- Where are the scenic spots around the campus which I can visit during the conference?
- Where are the locations of leisure activities on or near the conference location?

The first five in the list are potentially the most important questions for any conference delegate. The additional questions are of interest to delegates who wish to explore the campus and/or the surrounding town or locality.

3.1 Our Proposed Campus Navigation System

The China-Ireland Conference has been used as a case study by using the CloudMade API to provide a Campus Navigation System with the inclusion of transportation related information and markers showing other POI within Maynooth Town. Initial we identified the various buildings and POI relevant to this conference. This list is based on the location of buildings where the sessions are held, hotels where the delegates will stay, the local pubs and restaurants, and the important transportation POI like train stations and bus stops [32]. Figure 2 shows a flowchart of the system architecture of the proposed campus navigation system. And the different elements of the flowchart has been discussed in the following paragraphs.

Routing and Navigation. Routing finding is the most important feature of this system. As stated above we use the CloudMade API to provide a turn-by-turn descriptions of shortest routes for car users, bicycle riders, and pedestrians.

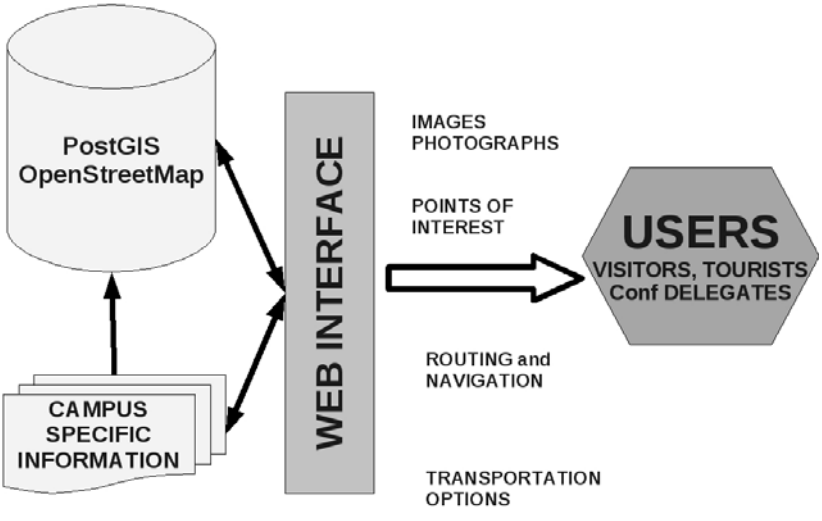

Fig. 2. A flowchart showing the system architecture for the campus navigation system

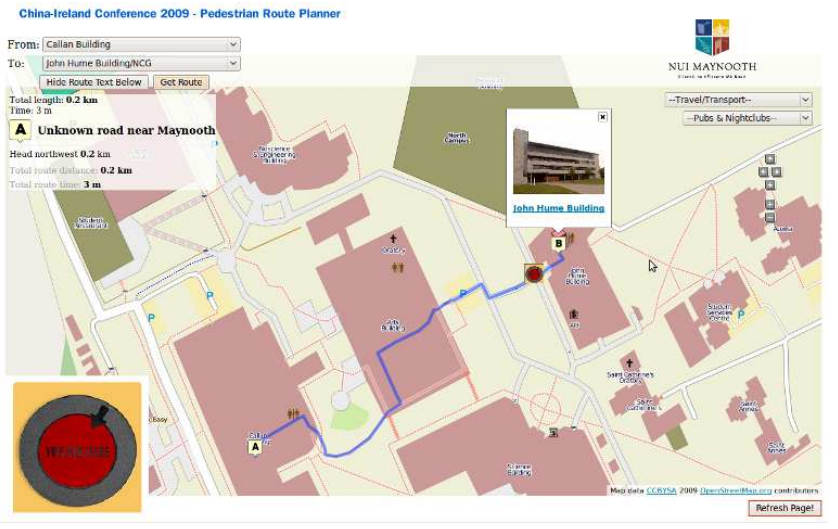

Fig. 3. The shortest pedestrian path between Callan and John Hume building using both internal corridors and external pavements

We have decided that we will only consider the case of pedestrian navigation around the campus. Most international delegates to the conference will not have access to an automobile or a bicycle during the duration of the conference. The data collection phase of the project has created a spatially rich OSM map of Maynooth. The richness of the OSM map of NUIM means that the CloudMade API can find routes on internal corridors and external footpaths, lanes, and streets. Figure 3 shows the shortest pedestrian path computed by the Cloudmade API between two buildings on the NUIM. The proposed route includes both indoor corridors and outdoor pedestrian pavements. The exact nature of the route is determined by the setting of the `travelMode` option as input to the route finding algorithm in the API. As mentioned above the choices available for `travelMode` are: $\{car, car/shortest, foot, bicycle\}$.

Geotagged Images and photos. Fourteen buildings and POI were identified in and around the campus that would be of relevance to the delegates attending the conference. For people new to an area the use of landmarks and geotagged images for navigation is of great assistance [33]. Figure 4 shows how the route description is supplemented with the insertion of geotagged images using markers at intersections or places where the user needs to change direction. These visual clues will help the user with orientation and assist them in their sense of direction when taking the suggested route. Figure 5 shows the deliivery of public transport travel information to the user if it is applicable to their chosen route. The system allows users to plan shortest routes between the specified set of buildings and POI. Users can also drag a marker and place it at any point on the campus from which they want to generate a shortest path from. The system dynamically

Fig. 4. Geotagged images used for assisting navigation

calculates the new shortest path and updates the map display accordingly. The geographical area from which the user can select a random points from which to plan new shortest paths between has been constrained to a 3KM grid centered on the campus.

Transportation options. Sometimes when visiting a conference location understanding the local public transportation system can be a difficult task for strangers to the area. There is always a need to provide the user with travel and transport related information. Figure 5 shows the use of markers at various transit points and information and suggestion are provided to the user in the information window. This provides users with the option to view information on how to travel from the NUIM campus to the nearby city of Dublin. The information provided includes fares, timetables and links to all the important websites that he/she needs for using the public transportation in the area. This feature should save users a lot of time by providing them with targeted local information.

Multi-lingual assistance. The China-Ireland conference is unique in that most of the delegates attending are either from Universities in Ireland or in China. The campus navigation system described in this paper includes pages in both English and Chinese. Figure 6 shows a screenshot of the campus navigation system interface provided in the Chinese language. We have incorporated the Chinese language to the system which includes the turn-by-turn description for routing and POI. In the future we also intend to include Irish, French, German, and Polish languages as the language options.

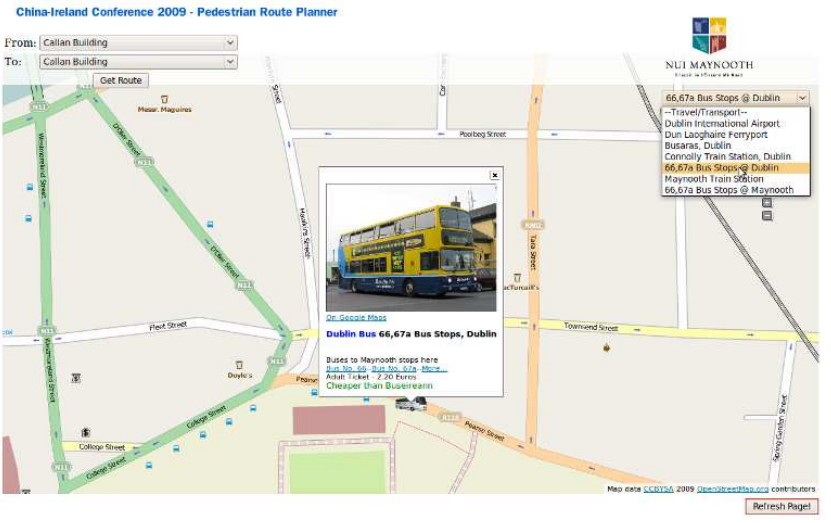

Fig. 5. The Dublin Bus travel information appears in the marker infowindow

Fig. 6. A screenshot of the campus navigation system interface provided in the Chinese language

4 Conclusions and Future Work

Cloudmade Web Lite API is still in an early stage of development. One of the problems with this "early adopters" stage is that there is little documentation

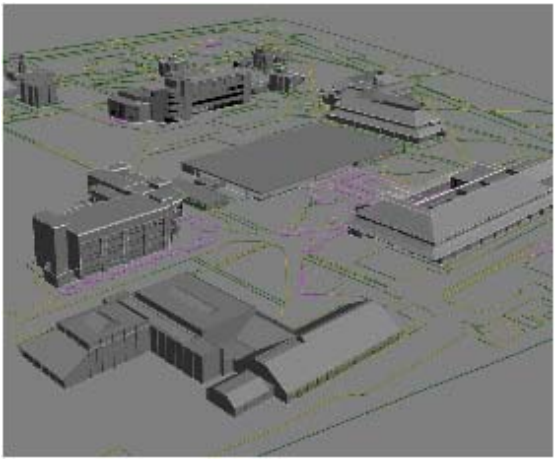

Fig. 7. An example of the 3D model of the NUIM campus [34]

to help developers working with the API. We see much potential in how we can customise the use of OSM data using the CloudMade Web Lite API. The present work designs a multi-lingual campus guidance system solution for international conferences in NUIM using map data from OpenStreetMap. It aims to be a common tool for any international conferences on the same campus. In this paper we demonstrated a prototype solution for the CIICT 2009 conference on NUIM campus. Currently it uses 2D maps for the guidance system. Images provide geovisual assistance at present. Consequently we intend to build a campus navigation system which is context aware and to make this user interface reusable by changing the schema and by making it customizable by any department in the university. The use of open geospatial technologies like Cloudmade API and OSM data are demonstarted here and we see it's use in creating such cost efficient applications. The larger research cluster we are working in has built a 3D model of the campus. In future work the extension of the campus navigation system with 3D visualisation inside and outside buildings will be investigated. Figure 7 shows a sample of the 3D model for the NUIM campus. It is hoped that this 3D extension will be provided also for mobile users in the near future.

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